UIC Workshop «Energy efficiency» Session Operation & Rolling Stock

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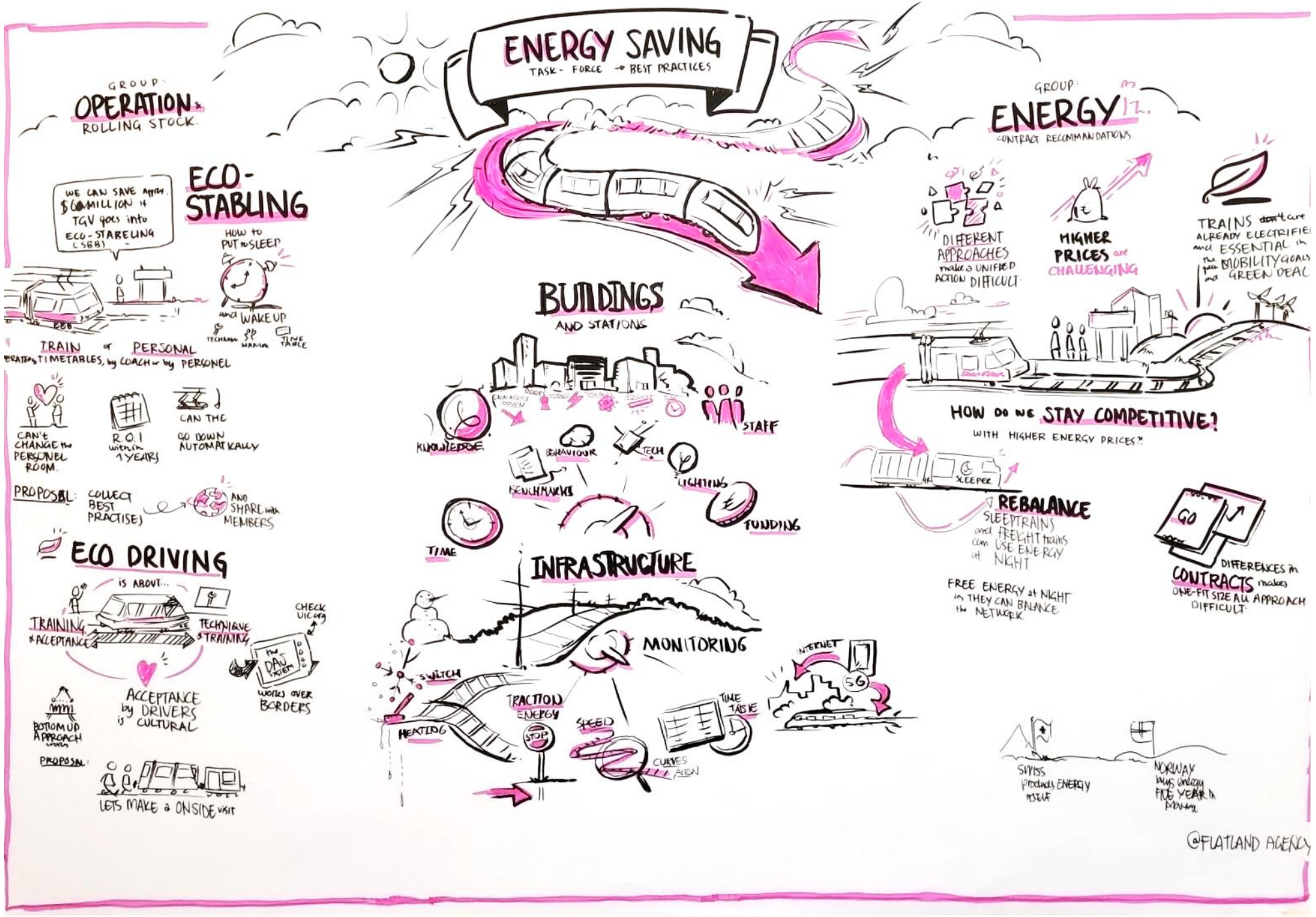
100 YEARS ANNIVERSARY

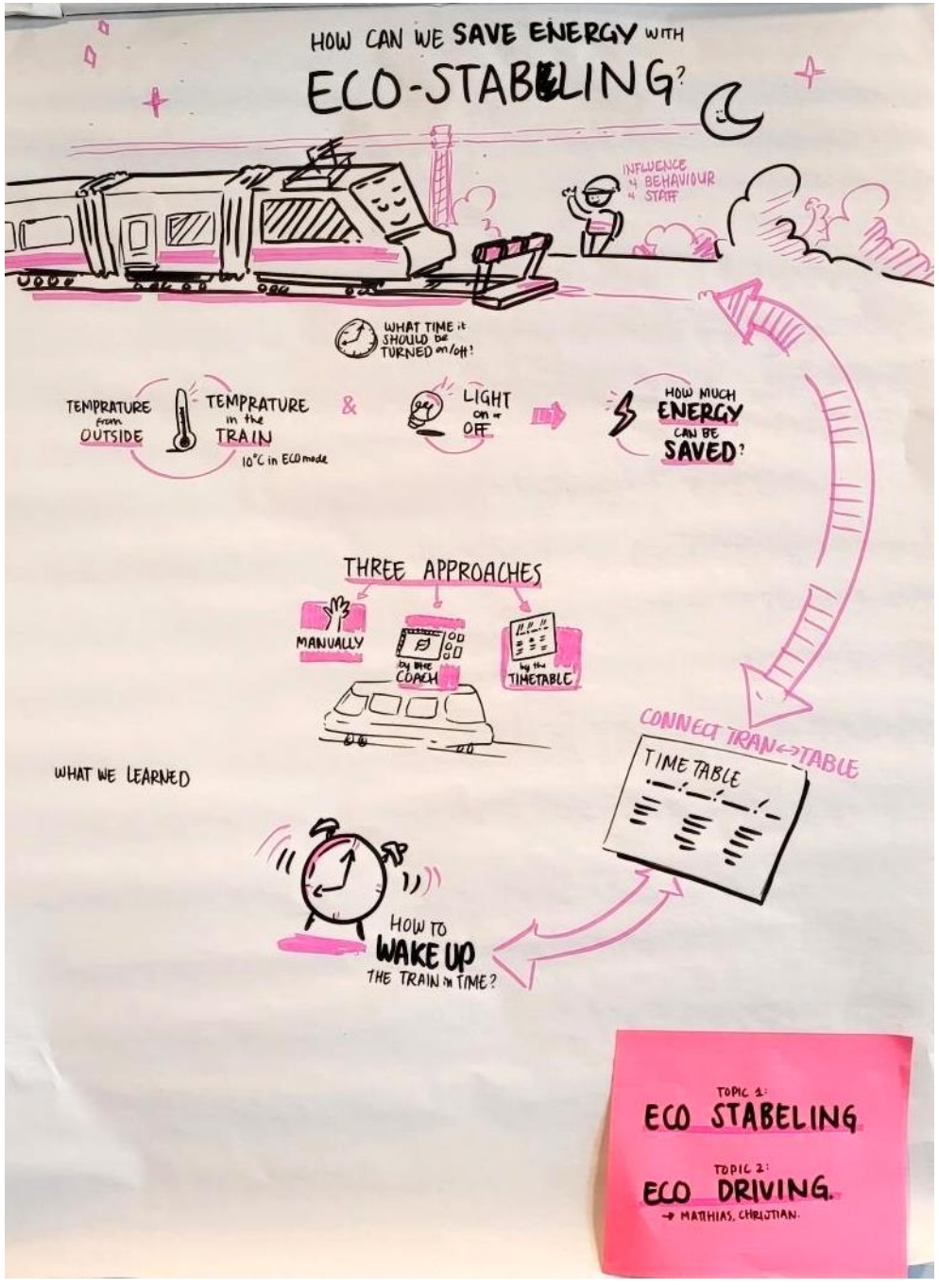
INTERNATIONAL UNION OF RAILWAYS

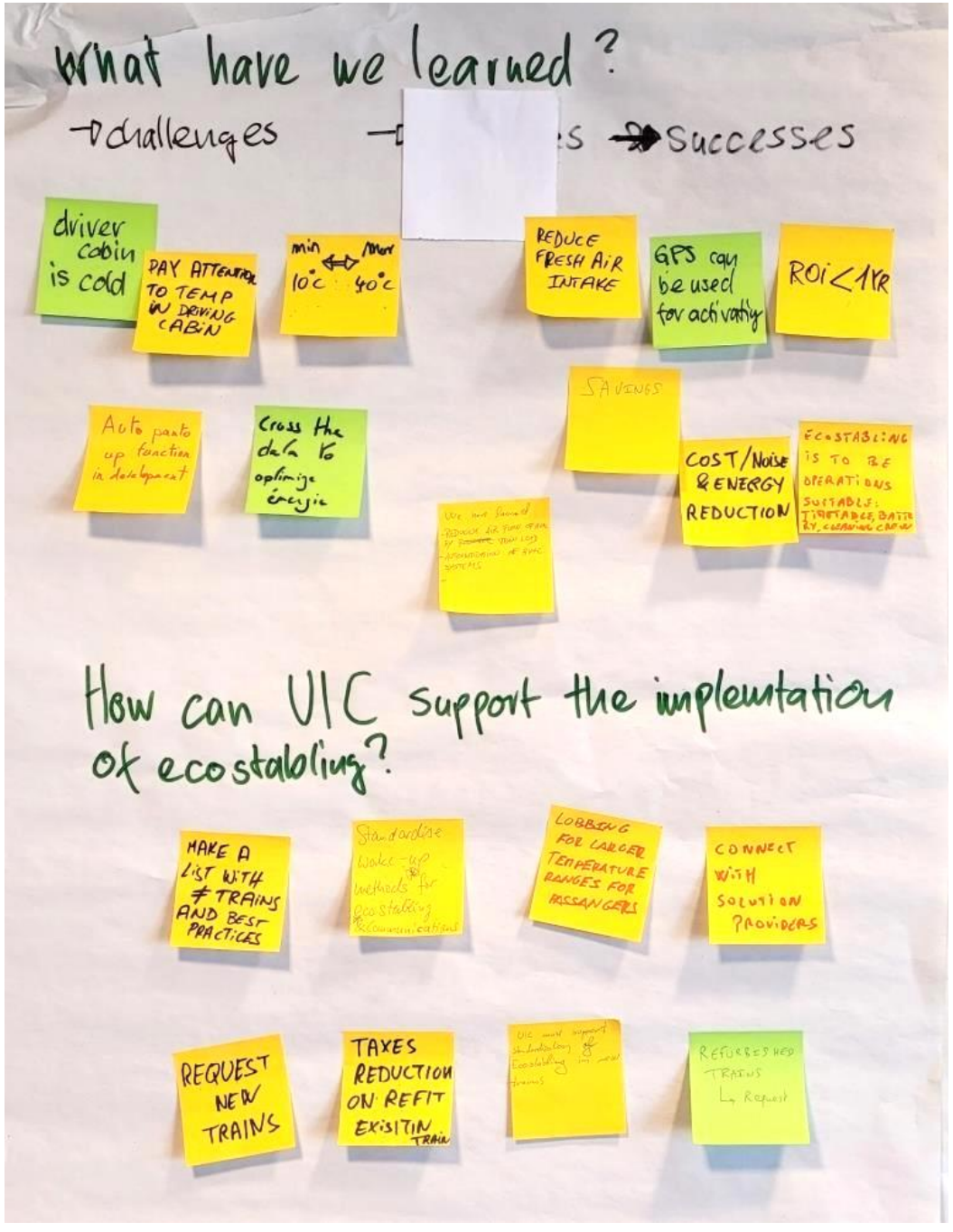
Impressions


ENERGY SAVING
TASK - FORCE → BEST PRACTICES
GROUP: OPERATION ROLLING STOCK
ECO-STABLING
WE CAN SAVE APPROX. $6 MILLION IF TGV goes into ECO-STABLING (SGB)
HOW TO PUT to SLEEP and WAKE UP
TECHNICAL MANUAL TIME TABLE
TRAIN or PERSONAL
TIMETABLES, by COACH or by PERSONEL
CAN't CHANGE the PERSONEL ROOM.
R.O.I within 7 YEARS
CAN THE GO DOWN AUTOMATICALLY
PROPOSAL: COLLECT BEST PRACTISES AND SHARE with MEMBERS
ECO DRIVING
is ABOUT...
TRAINING & ACCEPTANCE
TECHNIQUE & TRAINING
CHECK UIC.org
the DAU SYSTEM
WORKS OVER BORDERS
ACCEPTANCE by DRIVERS is CULTURAL
BOTTOM UP APPROACH
PROPOSAL
LETS MAKE a ONSIDE visit
BUILDINGS
AND STATIONS
KNOWLEDGE
STAFF
BEHAVIOUR
TECH
BENCHMARKS
LIGHTING
FUNDING
TIME
INFRASTRUCTURE
MONITORING
SWITCH
TRACTION ENERGY
STOP
SPEED
TIME TABLE
HEATING
CURVES
INTERNET
5G
GROUP: ENERGY
CONTRACT RECOMMANDATIONS
DIFFERENT APPROACHES make a UNIFIED ACTION DIFFICULT
HIGHER PRICES are CHALLENGING
TRAINS don't cure ALREADY ELECTRIFIED and ESSENTIAL in the MOBILITY GOALS and GREEN DEAL
HOW DO WE STAY COMPETITIVE?
WITH HIGHER ENERGY PRICES?
SLEEPER
REBALANCE
SLEEPTRAINS and FREIGHT trains can USE ENERGY at NIGHT
FREE ENERGY at NIGHT as THEY CAN BALANCE the NETWORK
GO
DIFFERENCES in CONTRACTS makes ONE-FIT SIZE ALL APPROACH DIFFICULT
SWISS produces ENERGY itself
NORWAY buys ENERGY FIVE YEARS in advance
@FLATLAND AGENCY

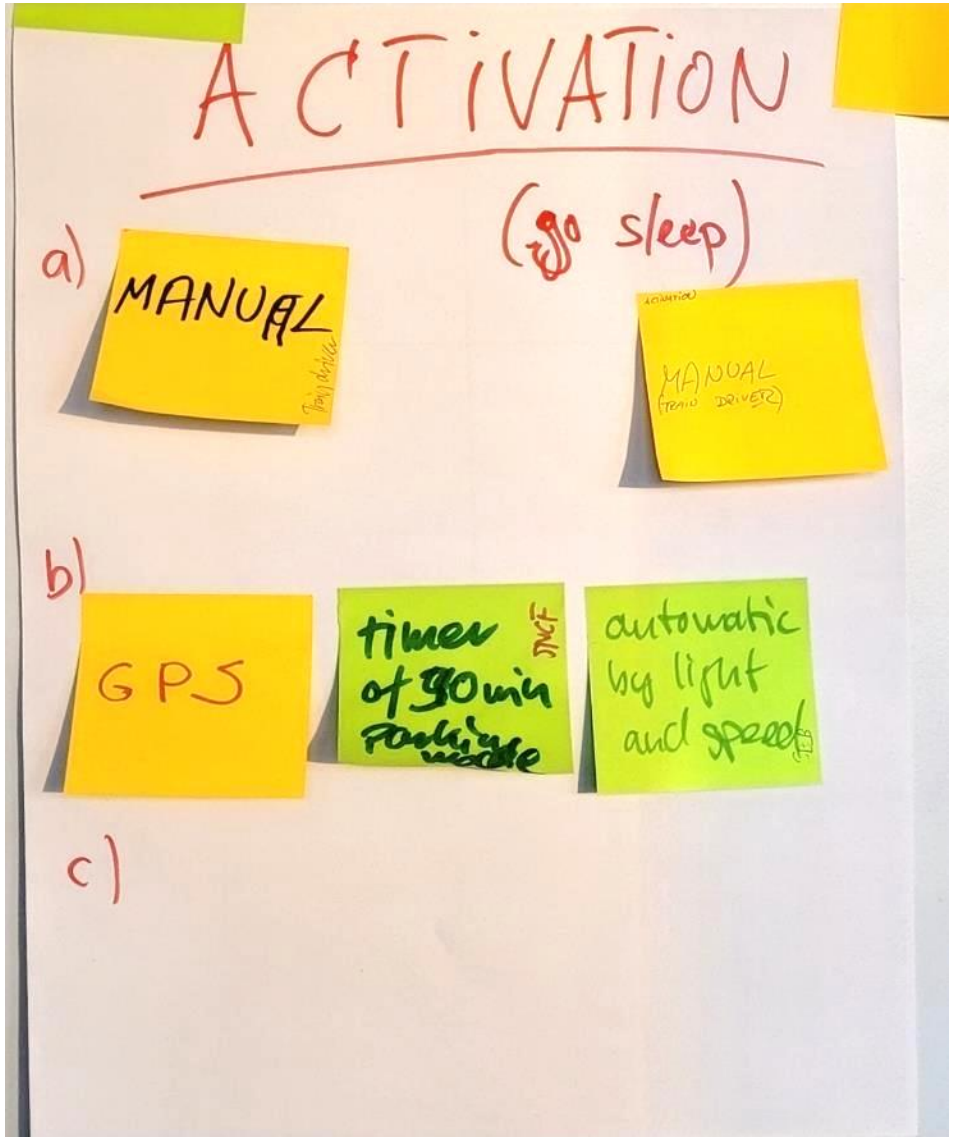
Results

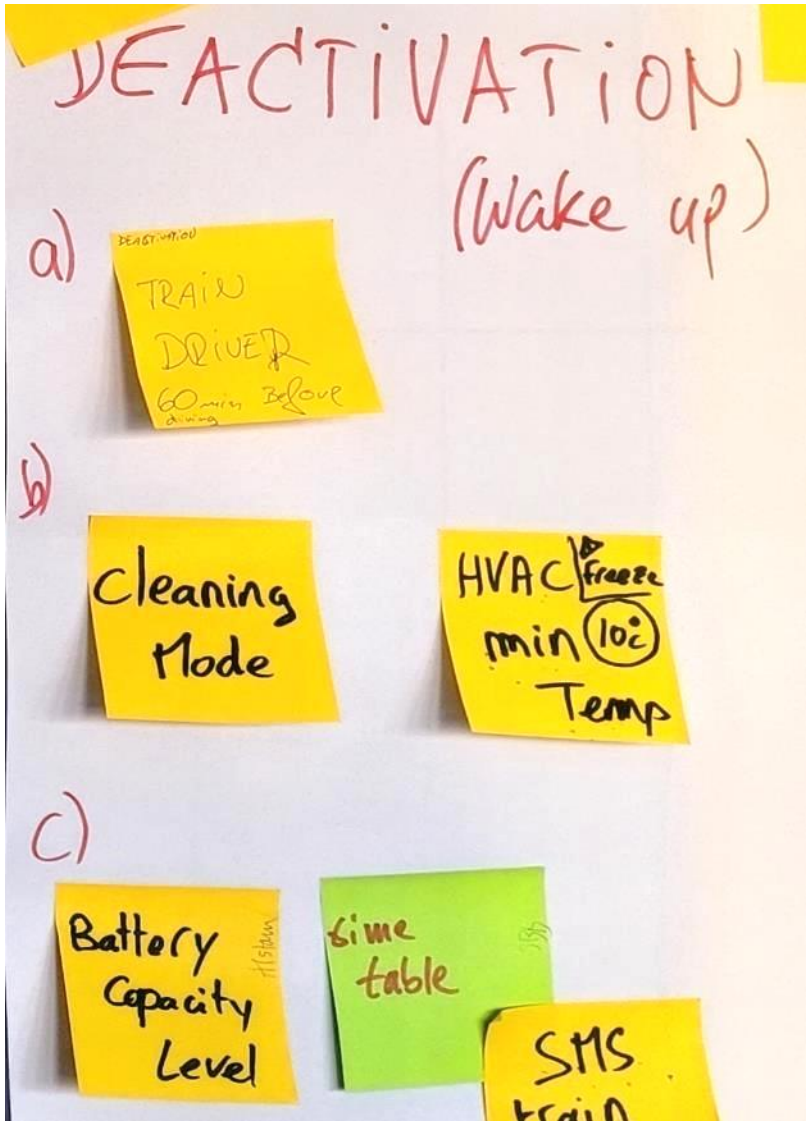
DeepDive «EcoStabling»


HOW CAN WE SAVE ENERGY WITH
ECO-STABELING?
INFLUENCE
BEHAVIOUR
STAFF
WHAT TIME it SHOULD be TURNED on/off?
TEMPRATURE from OUTSIDE
TEMPRATURE in the TRAIN
10°C in ECO mode
&
LIGHT on or OFF
HOW MUCH ENERGY CAN BE SAVED?
THREE APPROACHES
MANUALLY
by the COACH
by the TIMETABLE
CONNECT TRAN⇔TABLE
TIME TABLE
WHAT WE LEARNED
HOW TO WAKE UP THE TRAIN in TIME?
TOPIC 1:
ECO STABELING
TOPIC 2:
ECO DRIVING
→ MATTHIAS, CHRISTIAN.


What have we learned?
→challenges
→ Successes
driver cabin is cold
PAY ATTENTION TO TEMP IN DRIVING CABIN
min
10°c
max
40°c
REDUCE FRESH AIR INTAKE
GPS can be used for activity
ROI < 1YR
Auto pantu up function in development
Cross the data to optimize energie
SAVINGS
COST/Noise & ENERGY REDUCTION
ECOSTABLING IS TO BE OPERATIONS SUITABLE:
How can UIC support the implementation of ecostabling?
MAKE A LIST WITH # TRAINS AND BEST PRACTICES
Standardize Wake-up methods for ecostabling & communication
LOBBING FOR LARGER TEMPERATURE RANGES FOR PASSANGERS
CONNECT WITH SOLUTION PROVIDERS
REQUEST NEW TRAINS
TAXES REDUCTION ON REFIT EXISITIN
REFURBISHED TRAINS

Modes of activation / deactivation of ecostabling





Solutions and challenges when ecostabling

- Traindriver cabin is also cold
  - a lot of complaints
  - Skip ecostabling in driver cabin
- Only use floor heating in ecostabling HVAC
  - Advantage of noise reduction
- Concept of controlling ecostabling is documented in VöV D-RTE 48610
  - LINK: «Steuerung energieeffiziente Parkstellung Rollmaterial»
  - LINK « Gestion efficiente de l'énergie du matériel roulant en position Parc »

Lost and found page
- Items to exchange on in future workshops

- Setting directions for new trains (Jan Hoogenraad)
  - Key standards missing (Ecostabling, DAS)
  - include optimal design for ecostabling.
  - Standard Communication protocol for wake-up mechanism missing (but see VöV D-RTE 48610)
- Experience with SiC converters (Matthias Tuchschmid)
- Dispatching rules for operations (Jan Hoogenraad)
- Timetable creation for saving energy (Jan Hoogenraad)
- Switch of all not required systems in stabling (Jan Hoogenraad)
- Auto-close doors during ecostabling
- Expectations to new ERJU System pillar energy working group, RS, TMS
- Regenerative braking not allowed in France for Eurostar (45% savings lost)

Results

DeepDive «EcoDriving»

Ecodriving deepdive session (60 min)

Objectives / deliverables
→ Selection of 2-3 main solutions for ecodriving (le podium)
→ Next step proposal for going on deeper with UIC

Inputs:
- Two fact sheets for the topic from Task Force + processes
- Mindmap operations
- overview benchmark

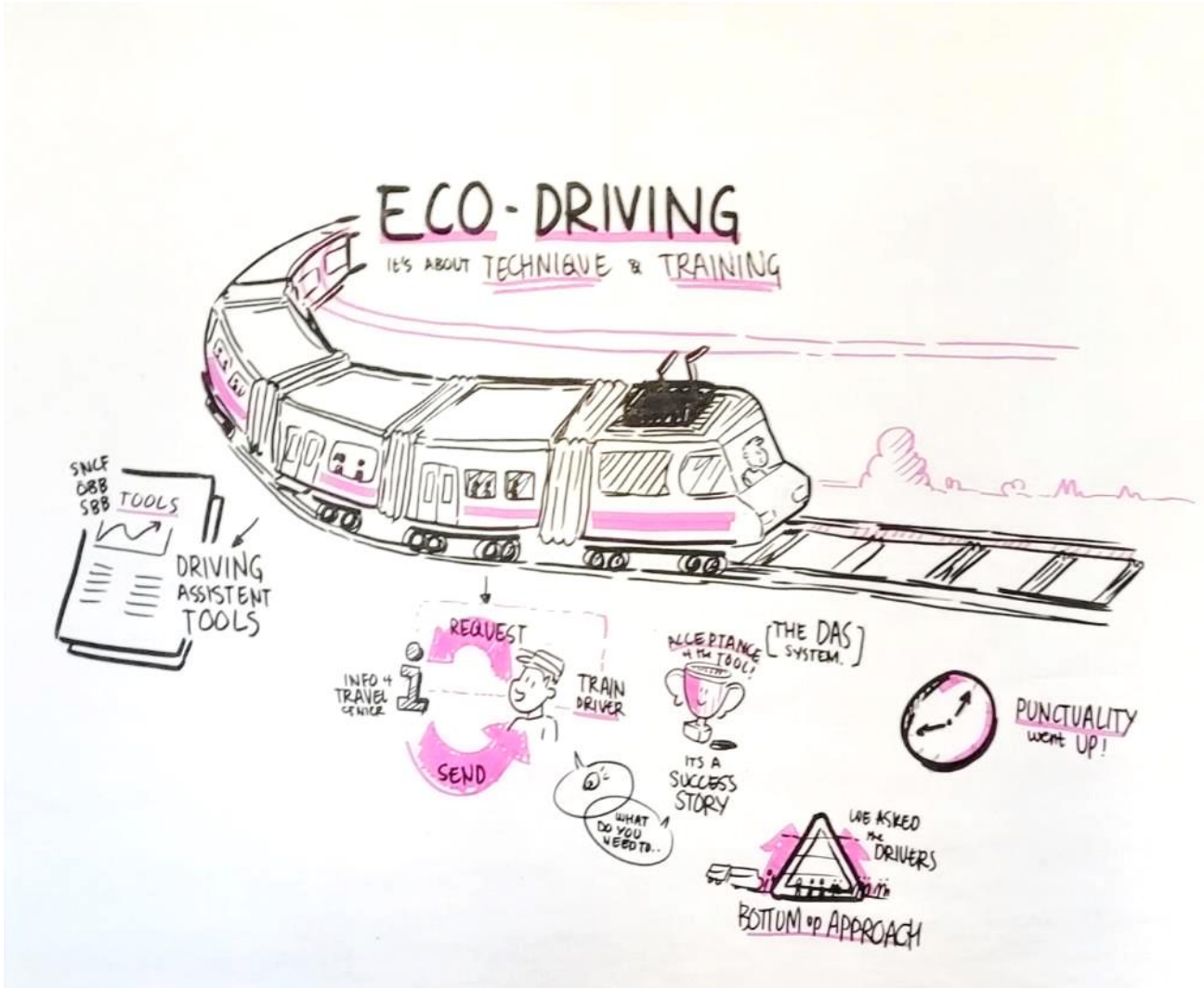
Méthod : 4 steps (10 min each)

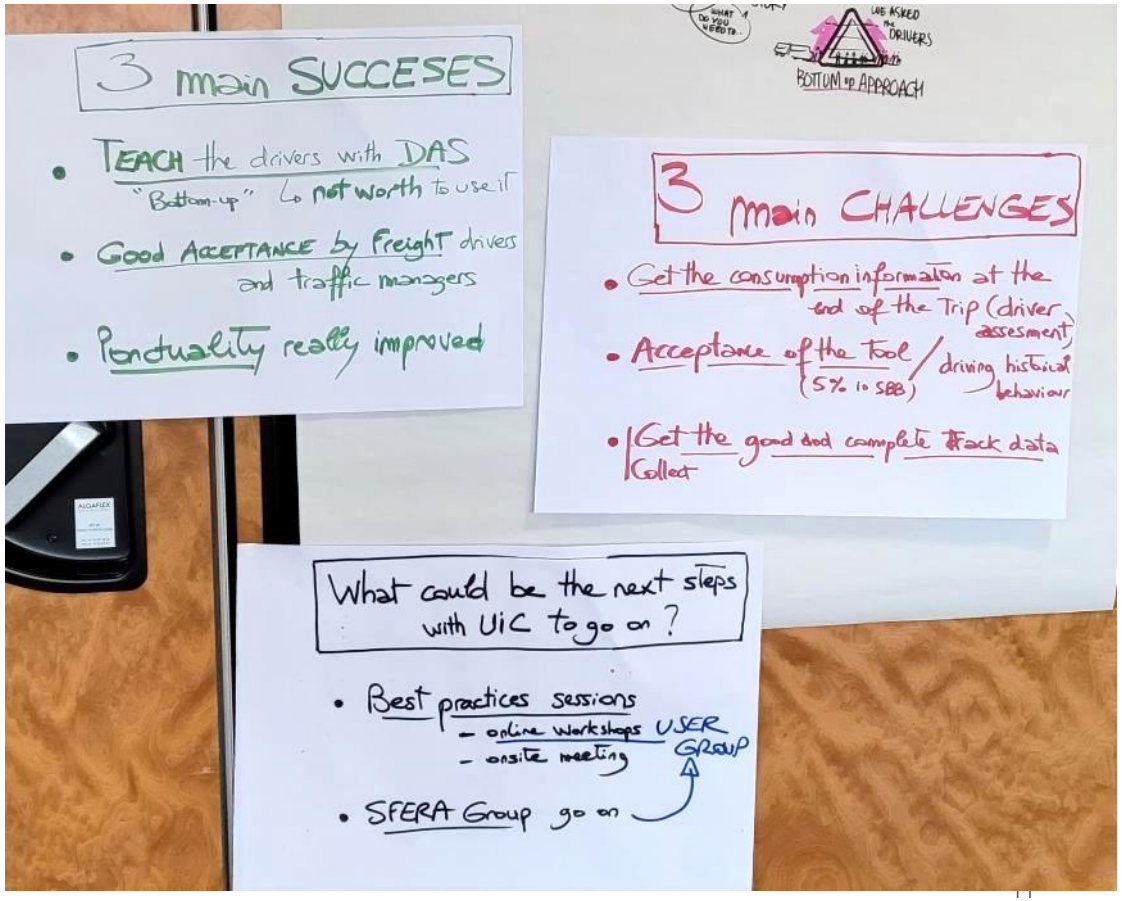
1. ECODRIVING mind map construction (solutions and company) – (paper board)
   - DAS / C-DAS (Training / incentives for drivers – impact measuring)
   - Without DAS (training/incentives – impact measuring : reduce the speed in the tunnel, …
   - Optimised timetables

2. Rating details for each solutions (5 ou 6 spider)

3. Successes and challenges from participants (compléter tableau sur ppt)

4. Synthesis (tableau ppt)
→ Selection of 2-3 main solutions for ecodriving (le podium)
→ Method proposal for going on deeper with UIC


ECO-DRIVING
IT'S ABOUT TECHNIQUE & TRAINING
SNCF
ÖBB
SBB
TOOLS
DRIVING ASSISTENT TOOLS
REQUEST
INFO 4 TRAVEL SERVICE
TRAIN DRIVER
SEND
ACCEPTANCE 4 THE TOOL!
[THE DAS SYSTEM]
IT'S A SUCCESS STORY
WHAT DO YOU NEED TO..
PUNCTUALITY went UP!
WE ASKED THE DRIVERS
BOTTUM up APPROACH


3 main SUCCESES
• TEACH the drivers with DAS
"Bottom-up" ↳ not worth to use it
• Good ACCEPTANCE by Freight drivers and traffic managers
• Punctuality really improved
3 main CHALLENGES
• Get the consumption information at the end of the Trip (driver assesment)
• Acceptance of the tool (5% to SBB) / driving historical behaviour
• Get the good and complete track data Collect
What could be the next steps with UIC to go on ?
• Best practices sessions
- online workshops
- onsite meeting
USER GROUP
• SFERA Group go on

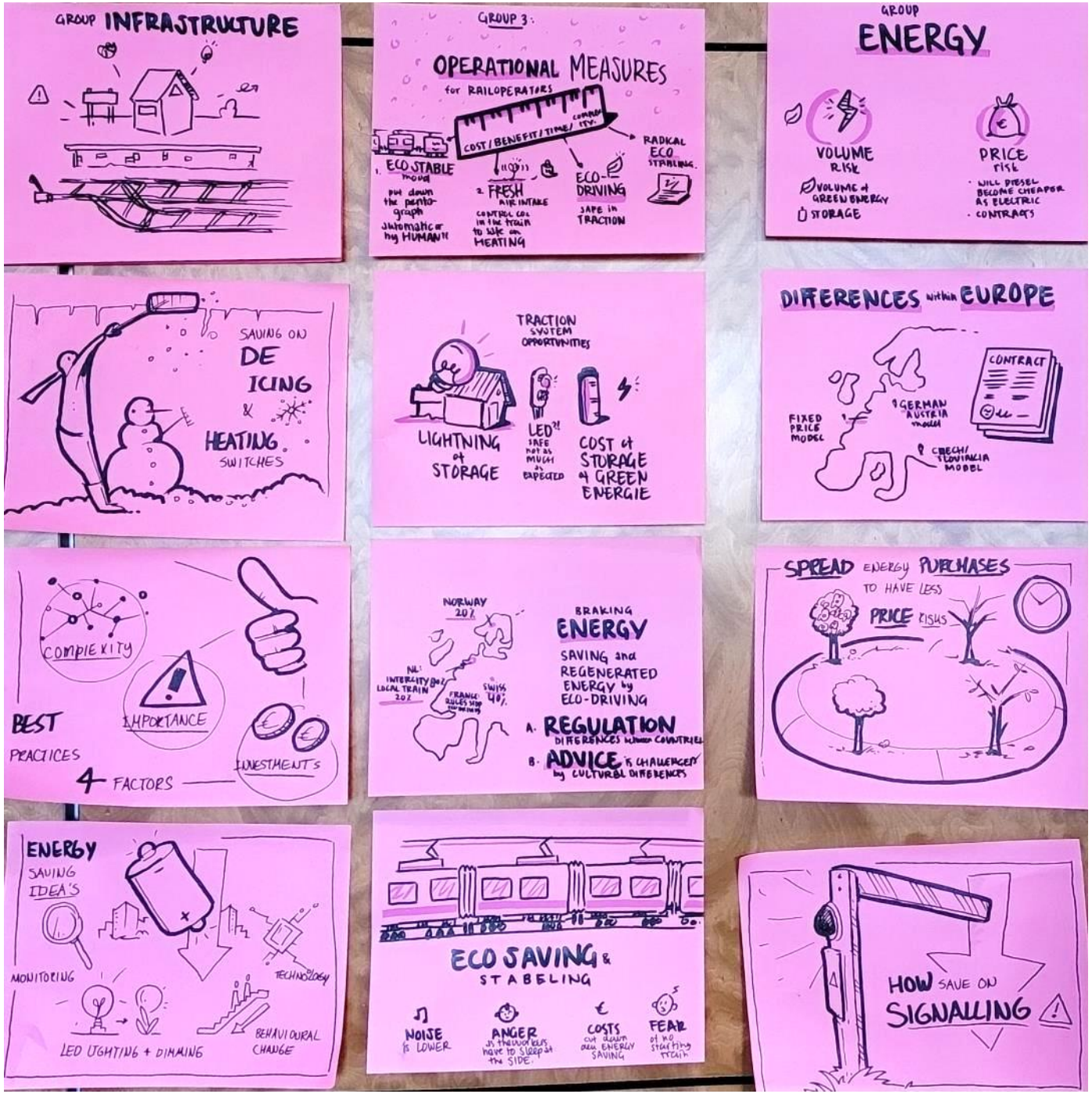
Ecodriving deepdive session (60 min)

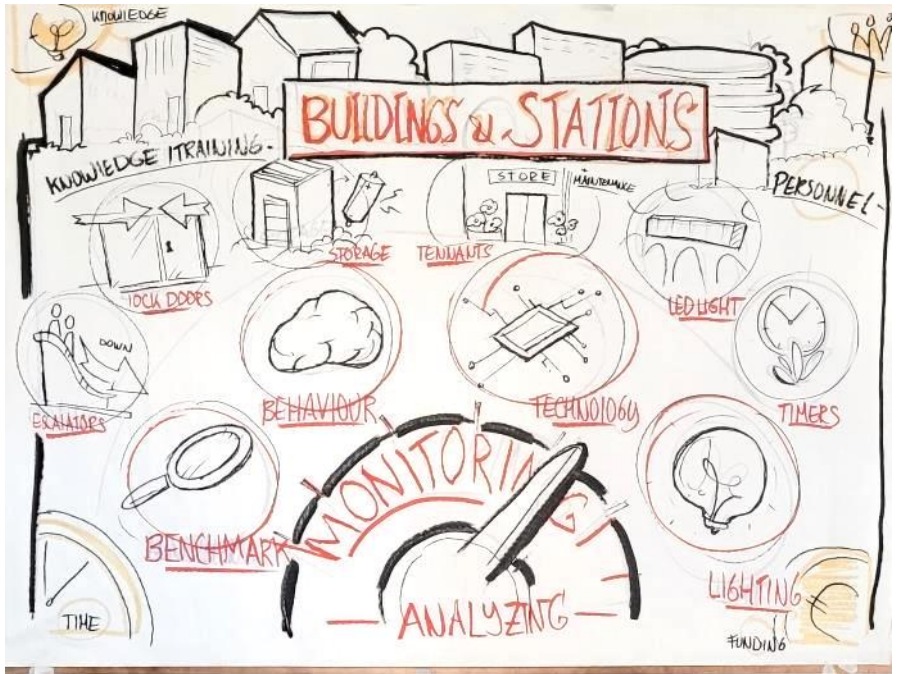
Who does what ? Succeses and challenges

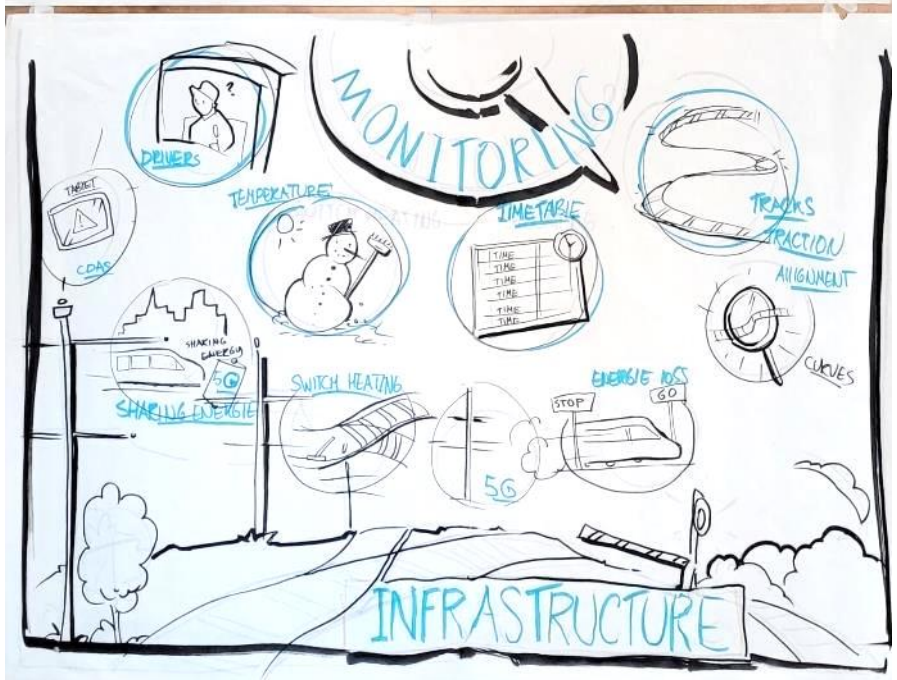
Who	What	Succeses	Challenges
SBB	C-DAS Driver tablet	Very good acceptance by freight drivers and traffic managers Consumption Information available at the end of the trip The ponctuality is really improved	Acceptance of the tool : 5 % of the drivers Cultural question « who is the king of the network ? «
	Reduce the speed in tunnel		
SNCF Voyageurs	DAS / C-DAS in devt	11 000 drivers trained and equiped Assesment system to measure acceptance for the tool	C-DAS Development because of infra data Provide the consumption information ontime at the end of the trip (permit the driver evaluation)
SNCF Réseau	C-DAS in devt		C-DAS Development
FS			
NS-PRORAIL	C-DAS 	Complete solution in accordance with SFERA 3000 drivers trained and equipped The drivers use the DAS for training ecodriving : use one time in the journey and after drive with the good habit Time tables very well designed in 6 seconds Energy saving monitoring by speed profille during the manual train step (4% saving energy) Bottom-up management C-DAS more as confirmation good eco-driving behaviour	
OBB	C-DAS		
TrafikVerket (sweden)	DAS		
Arlanda Express (Sweden)	DAS		
Infrabel	No DAS – forbideen		
First rail / scott rail (UK)	DAS		
CFL	C-DAS	Complete solution SFERA Thales aramis In time information TMS	Only a part of the network – go on step by step Freight : to be developped Collect all the infra information
DSB			

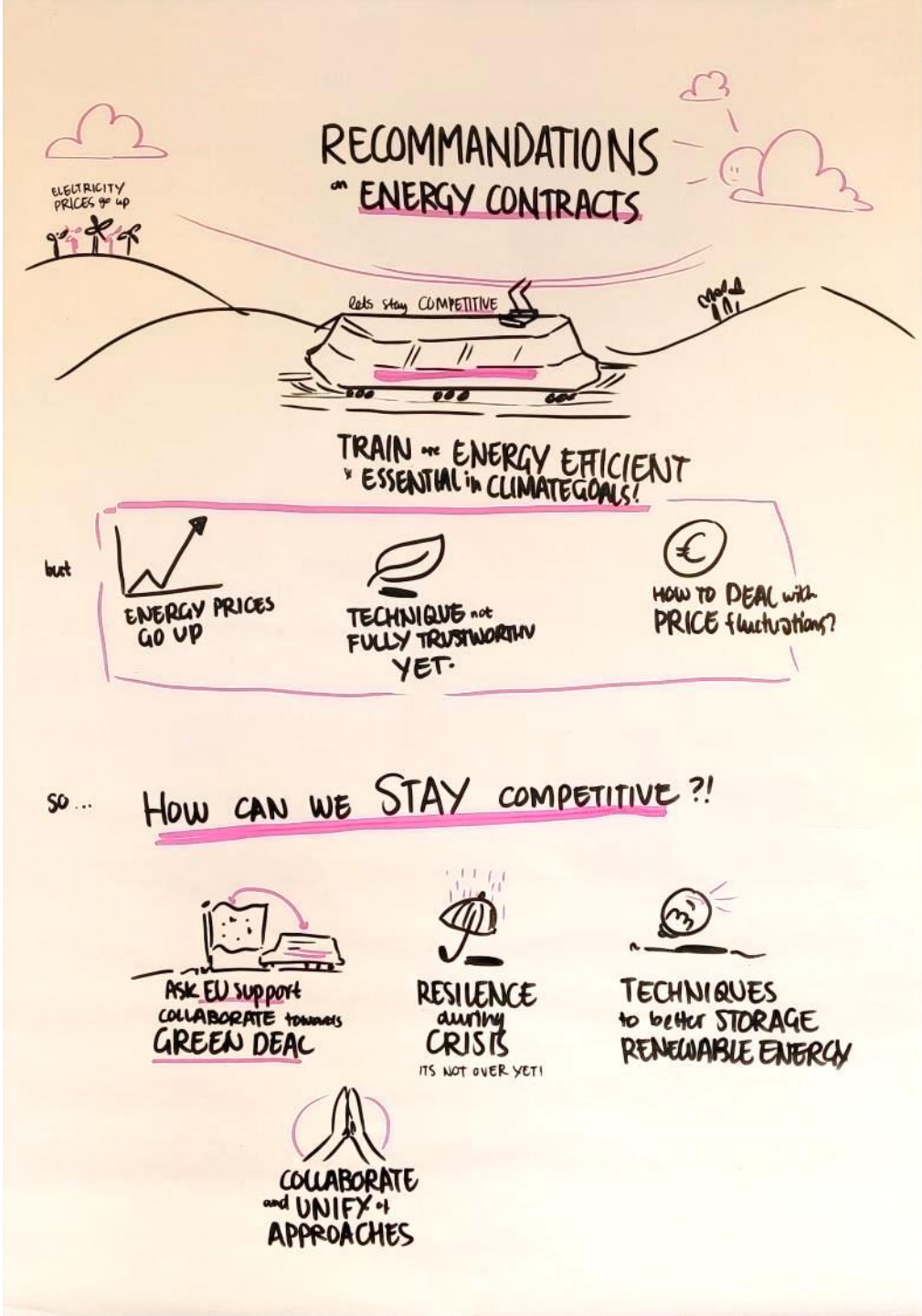
Results

Other Sessions


GROUP INFRASTRUCTURE
GROUP 3:
OPERATIONAL MEASURES
for RAILOPERATORS
COST / BENEFIT / TIME / COMFORT
RADICAL ECO STABELING
1. ECO STABLE
put down the pantographs
automatic or by HUMAN
2. FRESH AIR INTAKE
control CO2 in the train to use on HEATING
ECO-DRIVING
TAPE in TRACTION
GROUP
ENERGY
VOLUME RISK
VOLUME of GREEN ENERGY
STORAGE
PRICE RISK
WILL DIESEL BECOME CHEAPER AS ELECTRIC
CONTRACTS
SAVING ON
DE ICING
&
HEATING
SWITCHES
TRACTION SYSTEM OPPORTUNITIES
LIGHTNING of STORAGE
LED?!
SAFE but as MUCH as EXPECTED
COST of STORAGE of GREEN ENERGIE
DIFFERENCES within EUROPE
CONTRACT
FIXED PRICE MODEL
GERMAN AUSTRIA model
CZECH/ SLOVAKIA MODEL
COMPLEXITY
IMPORTANCE
INVESTMENTS
BEST
PRACTICES
4 FACTORS
NORWAY 20%
NL: INTERCITY 0% LOCAL TRAIN 20%
SWISS 40%
FRANCE RULES STOP TOO MUCH
BRAKING
ENERGY
SAVING and REGENERATED ENERGY by ECO-DRIVING
A. REGULATION
DIFFERENCES between COUNTRIES
B. ADVICE is CHALLENGED by CULTURAL DIFFERENCES
SPREAD ENERGY PURCHASES
TO HAVE LESS
PRICE RISKS
ENERGY
SAVING
IDEA'S
MONITORING
TECHNOLOGY
LED LIGHTING + DIMMING
BEHAVIOURAL CHANGE
ECO SAVING &
STABELING
NOISE
is LOWER
ANGER
as the workers have to STRIP at the SIDE.
COSTS
cut down new ENERGY SAVING
FEAR
of NO STAFFING TRAIN
HOW SAVE ON
SIGNALLING


KNOWLEDGE
BUILDINGS & STATIONS
KNOWLEDGE / TRAINING
STORE
MAINTENANCE
PERSONNEL
STORAGE
TENANTS
LOCK DOORS
LED LIGHT
DOWN
EXAMPLES
BEHAVIOUR
TECHNOLOGY
TIMERS
BENCHMARK
MONITORING
ANALYZING
LIGHTING
TIME
FUNDING


MONITORING
DRIVERS
TEMPERATURES
TIMETABLE
TRACKS
TRACTION
ALIGNMENT
CURVES
THROT
CDAS
SHARING ENERGY
SHARING ENERGIE
SWITCH HEATING
ENERGIE LOSS
STOP
GO
5G
INFRASTRUCTURE


RECOMMANDATIONS
on ENERGY CONTRACTS
ELECTRICITY PRICES go up
lets stay COMPETITIVE
TRAIN are ENERGY EFFICIENT
& ESSENTIAL in CLIMATEGOALS!
but
ENERGY PRICES GO UP
TECHNIQUE not FULLY TRUSTWORTHY YET.
HOW TO DEAL with PRICE fluctuations?
so ...
HOW CAN WE STAY COMPETITIVE ?!
ASK EU support COLLABORATE towards GREEN DEAL
RESILENCE during CRISIS
ITS NOT OVER YET!
TECHNIQUES to better STORAGE RENEWABLE ENERGY
COLLABORATE and UNIFY of APPROACHES

Slides

Overview

The operation of trains requires the most energy, and the greatest energy-saving potential is hidden in the areas of rolling stock and operational control. Together we would therefore like to answer the following questions in the workshop:

a. If you were employed as a consultant for a railway: Which 4-5 measures do you recommend to implement anyway, i.e. are quasi mandatory for all railway companies?

b. Which two energy-saving ideas would you take home for a more in-depth examination?

a. What method do you propose that UIC follow to go on with this depth-examination?

We would like to concentrate on measures that can be implemented in existing trains (not together with new procurements, such as a dry transformer in the train). The reason: We want to save energy here and now and as quickly as possible; a procurement usually takes several years.

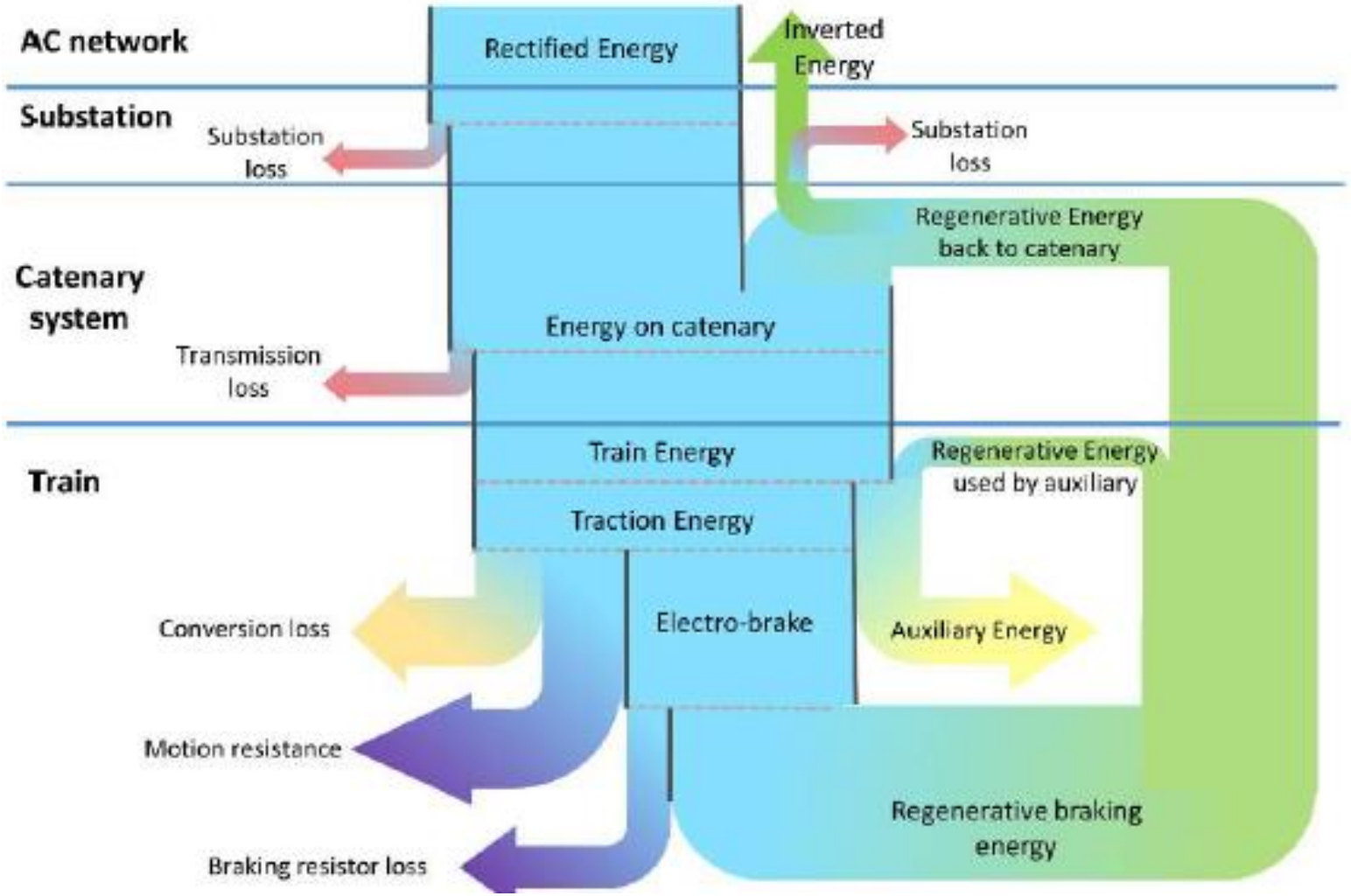
Agenda

Time	What
9:50 – 10:00 (10’)	Welcome and short round of introductions of the participants (maximum 20 participants)
10:00 – 10:15 (15’)	Introduction and overview by Christophe Gueudar-Delahaye (SNCF), Johannes Estermann (SBB), Matthias Tuchschmid (SBB), Christian Gerster (Alstom)
10:15 – 10:45 (30’)	Rating of the measures
10:45 – 11:00 (15’)	Coffee break
11:00 – 11:30 (30’)	Synthesis in 2 small group
11:30 – 11:50 (30’)	Synthesis in session group
11:50 – 12:20 (30’)	Presentation in the big group: What are the 3-5 most important measures?
	Lunch break
14:30 – 15:30 (60’)	DeepDive in small groups into the topics, for sure 1: ecostabling @ SBB, 2: ecodriving @ SNCF
15:30 – 16:00 (30’)	Preparing final synthesis • Each small group prepare 1-2 flipcharts
16:00 – 17:30 (90’)	• Presentation of the synthesis in the big group: What are the next steps? • How can the UIC taskforce support the implementation of the measures by the members?

Where is the energy consumed in the train?

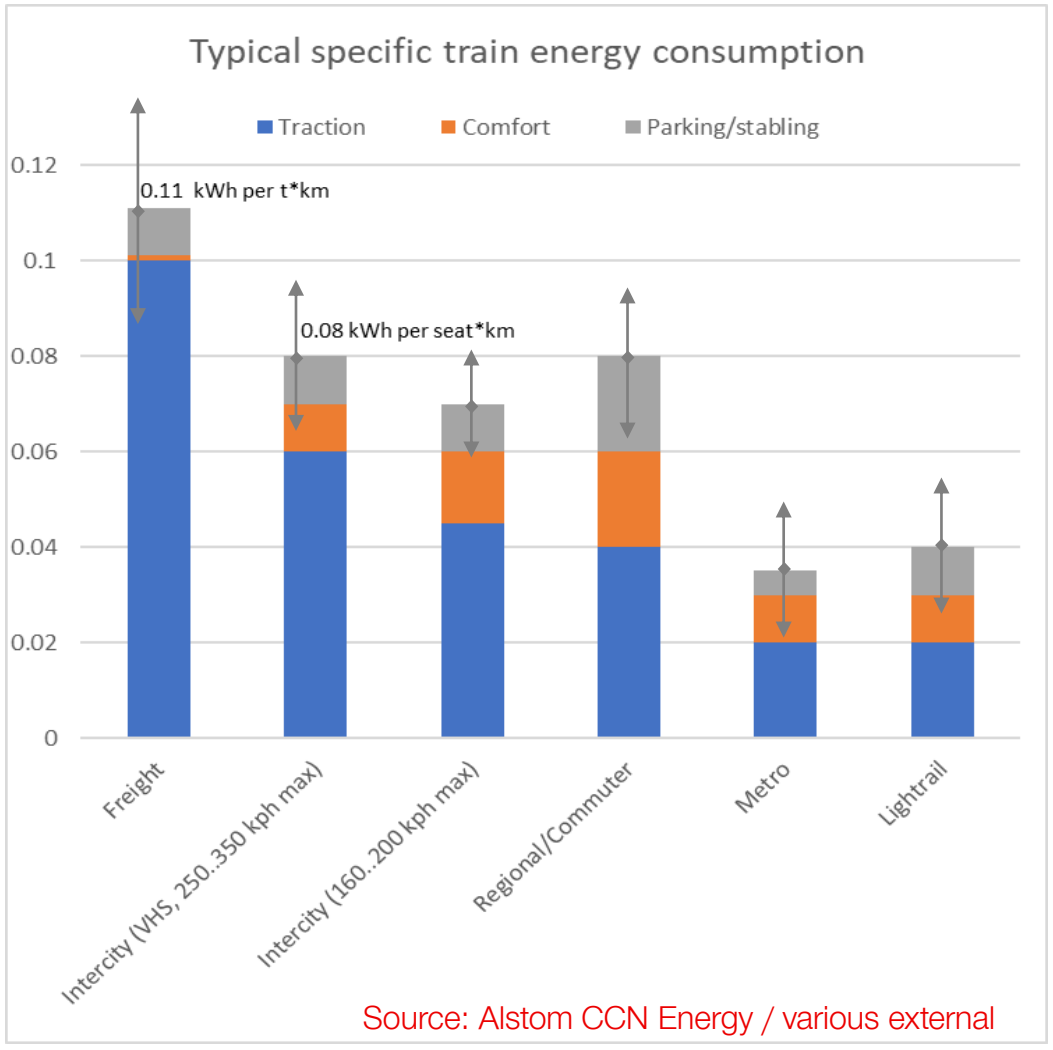
At 3.5 GWh per year, this long-distance train consumes as much electricity as 875 households.

Energy consumption in railway systems



Source: «Renewable power management into rail grid and storage » UIC workshop Nov 2022, Dr. Zhongbei Tian, University of Liverpool

Energy consumption of trains - indicative



Energy efficient Rolling Stock
- **Lightweight trains**
- Aerodynamics & running resistance
- Thermal insulation
- **Power supply and traction** efficiency
- **Efficient HVAC** (Cooling, heating)
- Energy reduced parking / stabling modes

Energy efficient infrastructure
- **Bidirectional substations** (DC networks)
- **Local energy storage**
- (Rail facilities heating, lighting,…)

Energy efficient operation
- Time table & train size
- **EcoDriving: connected DAS/Cruise control**
- Predictive energy opt. Stabling & Parking
- Comfort control: HVAC, lighting, doors etc.

Ways to save energy

a) Buy the best and most energy efficient rolling stock
b) Improve existing rolling stock
   I. with new components, e.g. LED as lighting source
   II. with new software, e.g. ecostabling

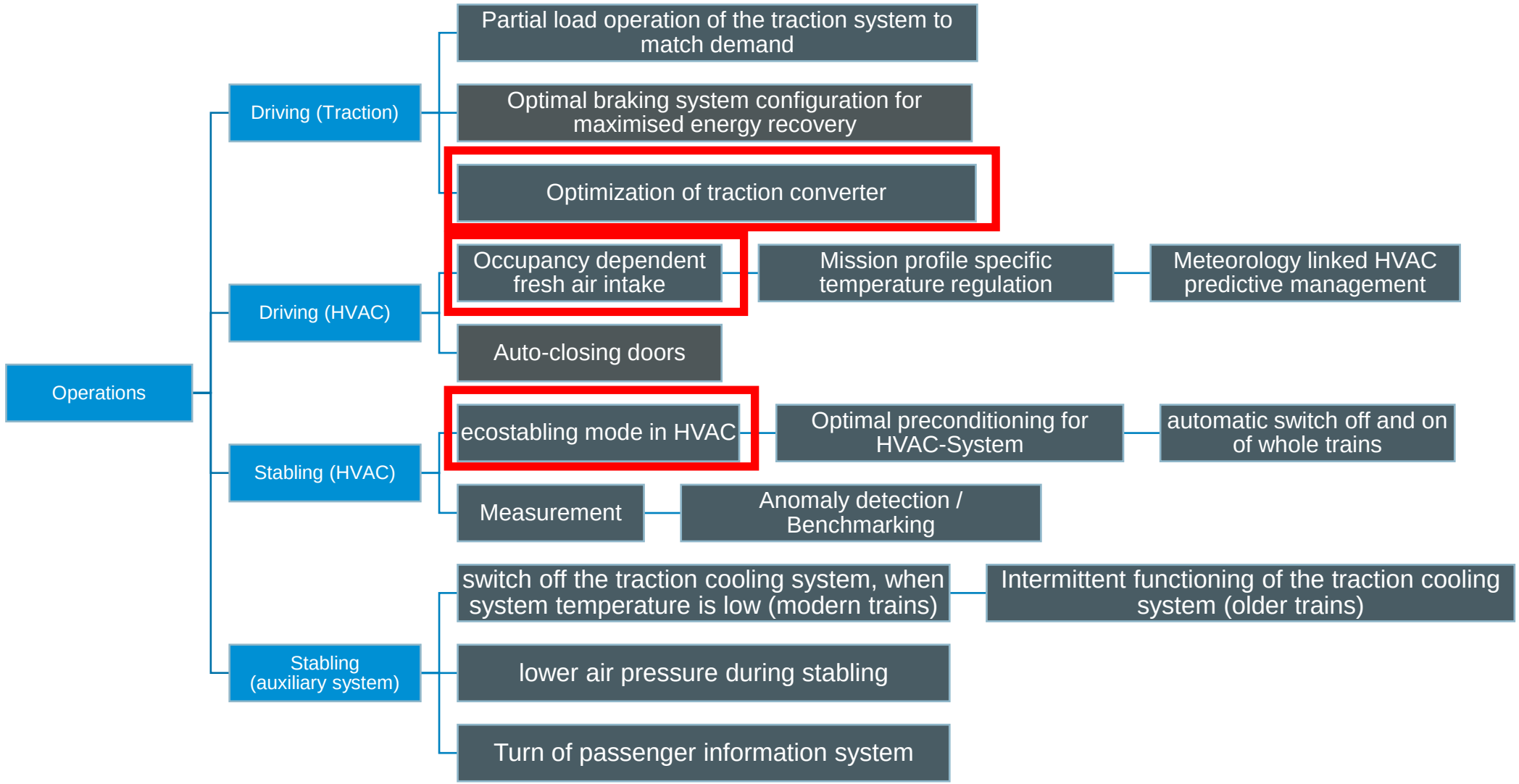
c) Stabling: Improve the way to use existing rolling stock, e.g ecostabling organisation

d) Driving: Improve the driving patterns of the trains, e.g. ecodriving information to train drivers

Which are the most important measures?

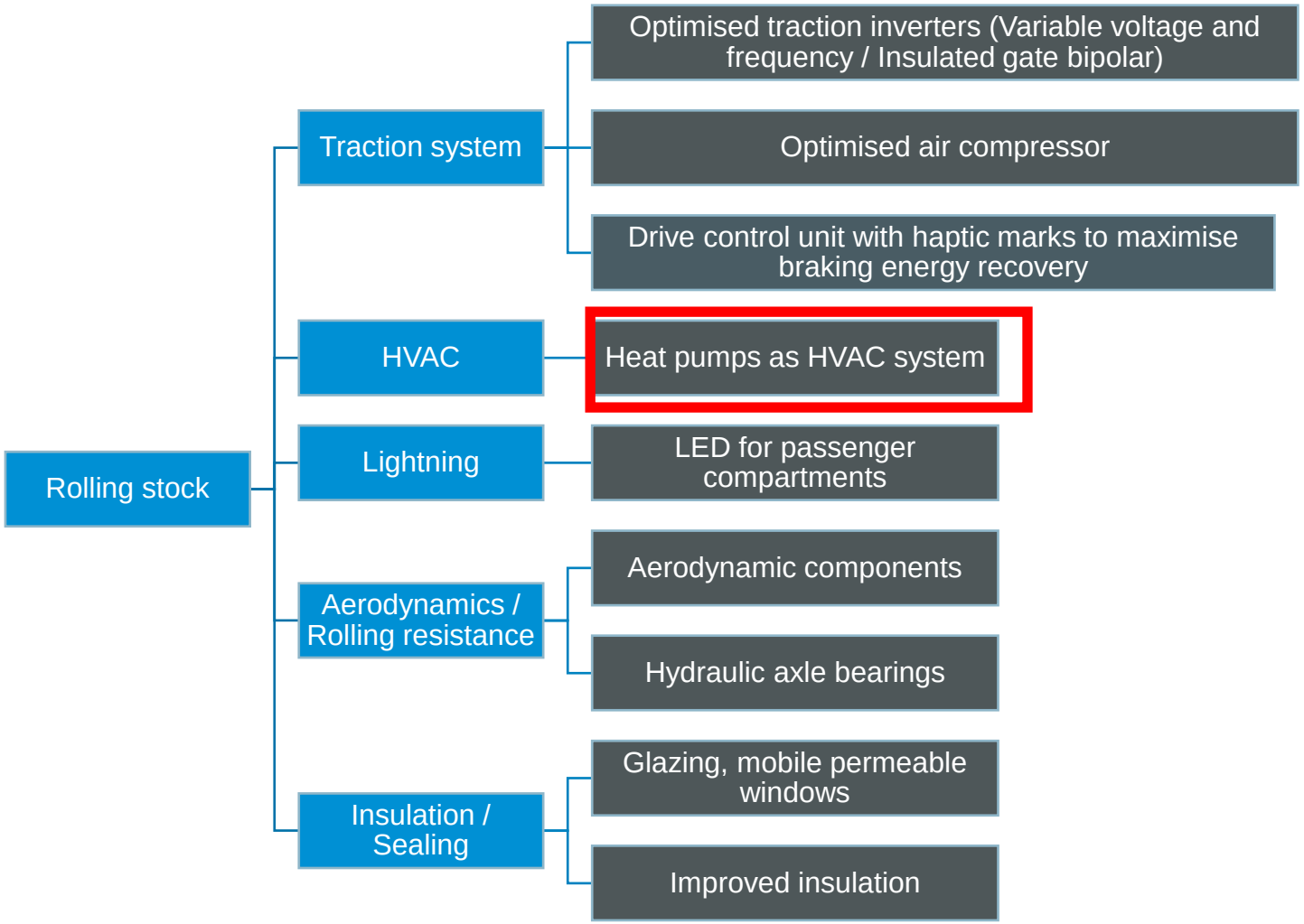
Rating the energy efficiency measures.

Operation - Solutions Mind map
Improve existing rolling stock with new software



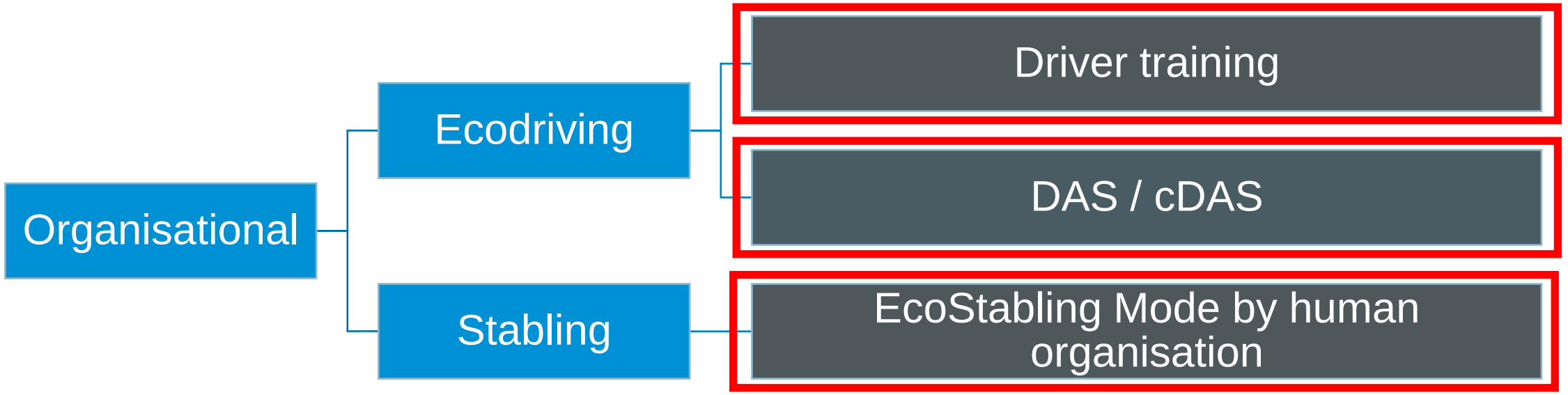
Operation - Solutions Mind map

Improve existing rolling stock with new components



Operation - Solutions Mind map

Organisational measures / processes for driving and stabling modes



Rated measures in Operation & Rollingstock

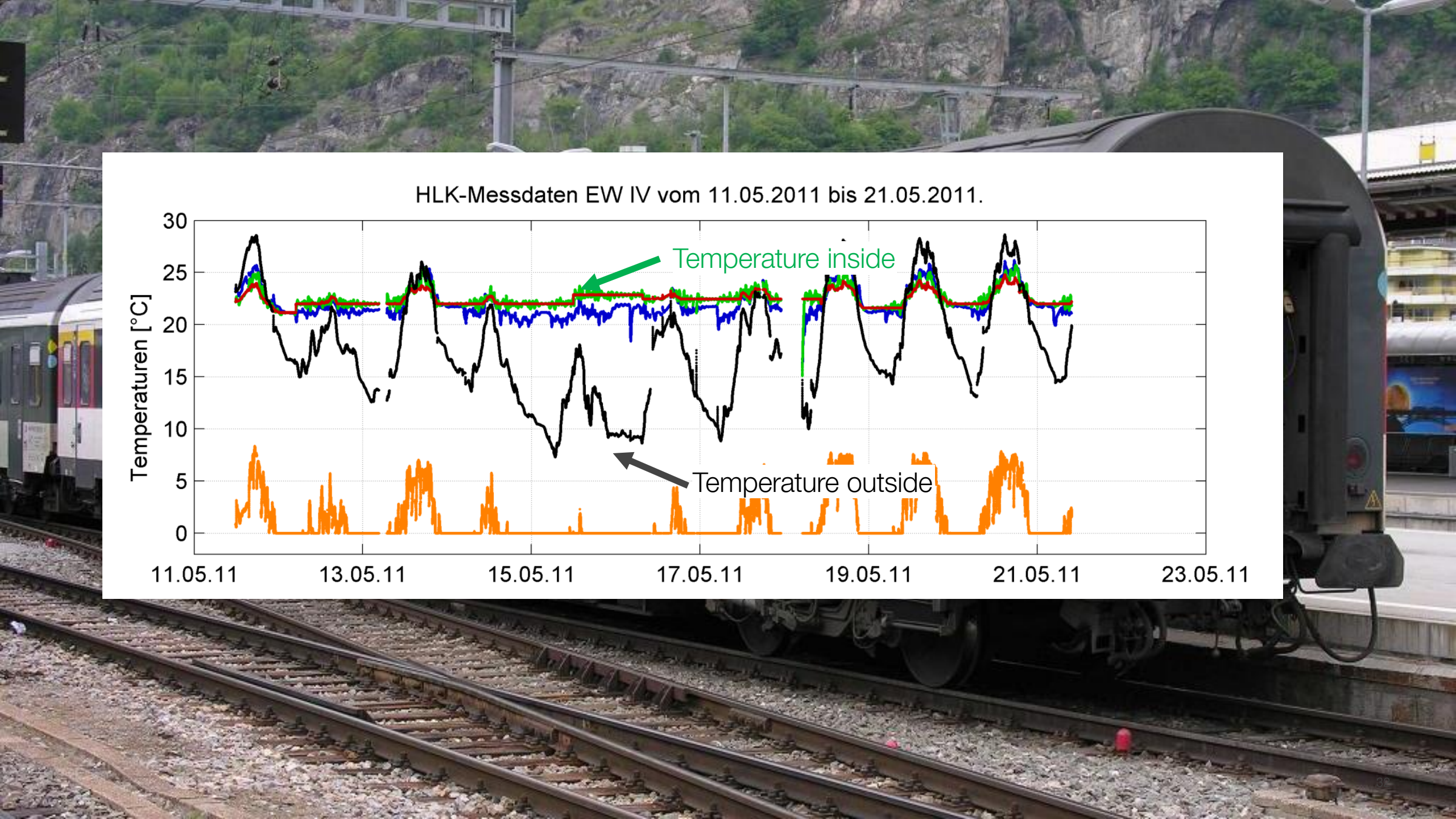
Topic	Introduction	Cost in Mio. EUR	Time	Compl	Benefit
1. EcoDriving training for drivers	Christophe	0.1	8 months	Low	2%
2. DAS / cDAS	Christian	0.8	2.5 years	High	6%
3. «EcoStabling»-Mode by human organisation	Christophe	0.01	1 year	Medium	1.8%
4. «Ecostabling mode» in HVAC (automatic)	Johannes	0.24	1 year	Medium	1.8%
5. Optimise traction converter software	Christian	0.8	2 years	High	4%
6. Occupancy-dependant fresh air intake	Matthias	0.1	1.5 years	Medium	0.6%
7. HVAC heat pumps	Johannes	0.4	2years	High	0.7% (0.1% – 10%)
8. Optimize Traffic management	Jan	1.2	3 years	High	4%

Remark: All values are an indication by the partcipants, typically with a range of +/- 50%

DeepDive EcoStabling

DeepDive «EcoStabling»

Time	What
14.30 – 14:35 (5’)	Welcome and goal of DeepDive
14:35 – 14:40 (5’)	1. Estimate the energy saving potential for your fleet and create a BusinessCase
14:40 – 14:55 (15’)	2. Implementation options: a) operational / manual b) Controlled by TCMS (on vehicle) c) controlled by timetable (from remote, connecticity to server) What is your experiences? What are advantages and disadvantages of these options?
14:55 – 15:10 (15’)	3. Example of implementation on a vehicle Example 1: EW 4 Example 2: FBB für EW4 Example 3: automatic switch off and on of whole trains
15:10 – 15:15 (5’)	4. Operational test and verification using data loggers, verification of BusinessCase
15:15 – 15:30 (15’)	5. Discussion and exchange: Success and challenges in implementation
15:30 – 15.50 (20’)	What have we learned? How can UIC support the implementation of the measures by the members?


HLK-Messdaten EW IV vom 11.05.2011 bis 21.05.2011.
Temperaturen [°C]
30
25
20
15
10
5
0
Temperature inside
Temperature outside
11.05.11
13.05.11
15.05.11
17.05.11
19.05.11
21.05.11
23.05.11

Potential for energy saving of ecostabling

Nicht festgelegt — C1 - Öffentlich — C2 - Intern — C3 - Vertraul

Energy saving potential with ecostabling

operating hours with passengers			7.8	[h/d]			specific energy capacity of air $c_{p,l}$			1.005	[kJ/(kg·K)]		
required hours for shunting and preparat			2.5	[h/d]			density of air			1.293	[kg/m³]		
Sum			10.3	[h/d]			average air intakte by Tout <-5°C			1106	[m³/h]	see specification of HVAC-	
factor of operation			43%				leaking rate by Tout<5°C			106	[m³/h]	estimation: 10%	
factor of reserve			9%				Mittl. Aussenluftanteil bei T>-5°C			1'106	[m³/h]	see specification of HVAC-	
faktor Schlummern			48%				Mittl. Leckage bei T>5°C			106	[m³/h]	estimation: 10%	
							coefficient of performance for cooling (			1.7			

temperature conditions				transmission						convection			
tout	hours	t_{in} normal	t_{in} ecostablin	k-Wert v = 0 km/h	k-Wert v = ⦸ km/h	A_m	per coach normal	per coach ecostabling	difference	$V_{l,e}$	per coach normal	per coach ecostabling	difference
[°C]	[h]	[°C]	[°C]	[W/m²K]	[W/m²K]	[m²]	[kWh]	[kWh]	[kWh]	[m³]	[kWh]	[kWh]	[kWh]
-15	20	22.0	17.0	1.8	2.1	268	172	148	23	1'106	142	123	19
-10	70	22.0	15.0	1.8	2.1	268	520	406	114	1'106	430	336	94
-4	290	22.0	14.0	1.8	2.1	268	1'749	1'211	538	1'106	1'447	1'002	445
0	730	22.0	12.0	1.8	2.1	268	3'725	2'032	1'693	1'106	3'083	1'682	1'401
5	1'670	22.0	11.0	1.8	2.1	268	6'585	2'324	4'261	1'106	5'450	1'923	3'526
10	1'850	22.0	10.0	1.8	2.1	268	5'149	0	5'149	1'106	4'262	0	4'262
15	1'680	22.0	15.0	1.8	2.1	268	2'728	0	2'728	1'106	2'257	0	2'257
20	1'190	22.0	20.0	1.8	2.1	268	552	0	552	1'106	457	0	457
22	550	22.4	22.0	1.8	2.1	268	51	0	51	1'106	42	0	42
24	320	23.4	24.0	1.8	2.1	268	26	0	26	1'106	22	0	22
26	170	23.8	26.0	1.8	2.1	268	51	0	51	1'106	42	0	42
28	100	24.5	28.0	1.8	2.1	268	48	0	48	1'106	40	0	40
30	70	25.5	30.0	1.8	2.1	268	43	0	43	1'106	36	0	36
35	50	30.0	35.0	1.8	2.1	268	34	0	34	1'106	28	0	28
				Aufheizen & Unsicherheit (Annahme 20%)				1'224	-1'224	Aufheizen & Unsicherheit		1'013	
Sum	**8'760**						**21'433**	**7'346**	**14'087**		**17'737**	**6'079**	**12'672**

energyconsumption without ecostabling	[MWh]	39.2
energyconsumption with ecostabling	[MWh]	13.4
energy saving potential with ecostabling [MWh]	**[MWh]**	**25.7**

Nebenrechnung Aussenluftvolumenstrom & Oberfläche

Fzg.-Typ	Personen	Aussenluft t_{em} < -5°C	Aussenluft t_{em} ≥ -5°C	Fahrzeuge	Oberfläche
	[Anzahl]	[m³/h]	[m³/h]	[Stck.]	[m²]

Einsparung für gesamte EW IV-Flotte

Anzahl Fahrzeuge	Einsparung Flotte	
334	8.6	[GWh]

- Physical model in Excel
- Required are some basic parameters

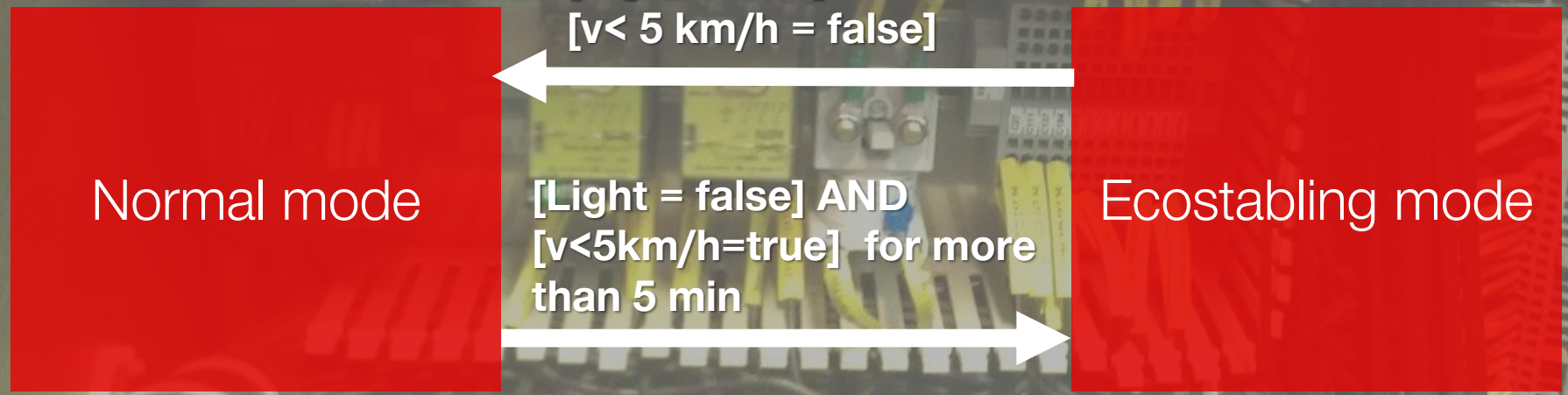
You can download the file from the UIC-Extranet.

Three different approaches for activating the «ecostabling» mode

a) operationally / manually
b) controlled by coach (automatically, by TCMS)
c) controlled by timetable (from remote, connecticity to server)

- What is turned off when?
- Which signals are used?
- Who and when is the train prepared for operation again?

Implementation of new operational state «Ecostabling mode»



Switch remotely on and off the light, controlled by the timetable

Coach

KIS
RIO / RIU

SSTdez

FZPF
Logik und StateMachine

Monolith

TCP/IP: SSTmobile / GSM-P

Transfer starting time of operation

Train illuminastion ON / OFF
(by UIC-Leitung)

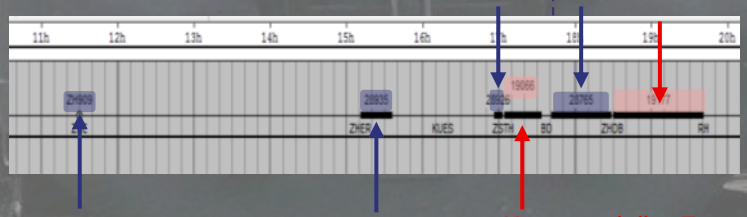
EcoStabling of train

Server

FZPF-Z

CERES

Timetabling tool



Unterhalt oder etc.

Kommerzieller Zug